

A Web-Based Architecture for Interactive Electronic Technical Manuals (IETMs)

Abstract

This paper presents a concept of a Web-based Architecture for achieving user-level interoperability of DoD Interactive Electronic Technical Manuals so that an end user can view any DoD IETM, no matter what the source, using only one electronic display device and common set of browser software. The particular solution presented is that developed by a study performed for the Navy; however, the paper also discusses the effort to extend the Navy Architecture to all of DoD. The DoD effort is being undertaken by a Tri-Service team chartered by the Assistant Undersecretary of Defense (Logistics Reinvention and Modernization). The Architecture is being developed in response to a requirement from the Joint Logistics Commanders, which identifies that non-interoperability of IETMs as a major impediment in conducting Joint Operations.

Introduction

A revolution in Information Technology in the last ten years has also revolutionized the Navy's way of acquiring, managing, and presenting to the Fleet the Technical Information required to train for, maintain, and operate its weapon systems.

During this period, millions of pages of paper Technical Manuals have been digitized and stored in electronic form by the Navy and by the other Services. Warehouses full of paper Technical Manuals are becoming a thing of the past. An information-system infrastructure based on hard copy is being converted to a computer-controlled infrastructure that can provide high-speed, on-line information availability on a worldwide basis.

As capacity, speed, and availability of small computers increased by orders of magnitude, a number of long-anticipated improvements in providing weapon-support information can now

become a reality. Thus, for the first time, the presentation of maintenance information to shipboard and flight-line technicians is made possible, with the advent of the Interactive Electronic Technical Manual (or IETM).

An IETM is a Technical Manual, authored by a contractor or by the Government in digital form, designed for electronic (screen) display to an end user, with three innovative characteristics not possible with paper Technical Manuals (TMs). These three characteristics are:

- Optimized style and organization of information for computer-screen presentation; i.e., frame-oriented vs page-oriented presentation with such additional capabilities as scrolling, zooming, color, motion, and sound.
- Enormously improved access to required information on a practically instantaneous basis, through a variety of paths.
- Interactivity between the user and the Technical Information (TI); the computer-based IETM can provide procedural guidance (based on user input), navigational directions, and logistic-support functions supplemental to maintenance (such as maintenance reporting, parts ordering, etc.).

Test after test in the Navy with both surface and air weapon systems, ashore and afloat, under operationally realistic conditions, has shown the superiority of this mode of information presentation at the end-user level, and its acceptance by Fleet users.

As a result, during the last few years, many System Acquisition Managers who are developing new systems, in all of the Services, have established requirements for IETMs containing weapon-support Technical Information, and are acquiring and fielding this type of TI. Others are converting existing paper manuals (legacy data) to IETM form in order to

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realize the life-cycle benefits achievable in effectiveness and reduced handling costs.

The Problem

As is the case with the implementation of any new technology, technical problems have arisen in effecting these changes. At the same time, changes in the military environment have occurred; for example, a change to a more Commercial Off-The-Shelf (COTS)-oriented acquisition philosophy, downsizing of Government facilities, reduction of available funds, and an increasing emphasis in the Department of Defense (DoD) on Joint operations, weapon systems, and information procedures. Each of these factors has had profound effects on procedures for acquiring and managing Technical Information in such a way that its full potential can be applied to supporting the warfighter in the face of the increased demands of system complexity, wide dispersal of facilities, fewer personnel, and the greater need for quick reactions.

One major problem that has arisen is a need for greater interoperability; i.e., the requirement that technicians of one Service, must during Joint Operations be able to maintain and, at times operate, weapon systems of another Service by accessing that other Service's technical information, using the single electronic display device originally issued to the technician. Ideally, interoperability of weapon systems within the DoD should be such that any user is able to access all relevant data systems (consistent with security limitations) using only one display device. In order to make that information easily available to the user (e.g., on a common intranet in the field), it is important that the barriers to the smooth flow of information throughout the logistic-support structure have been eliminated.

The achievement of such Technical Information interoperability is by no means inherent in IETM-acquisition procedures that have been developed over the last few years. This results, because a System Acquisition Manager is required to construct his own new development path from the establishment of interactive digitized product information, through the

support infrastructure, to the IETM presentation system. Although several military Specifications were developed and promulgated throughout the DoD for use in IETM acquisition, their emphasis was on performance requirements and not on assuring standardization of hardware, software, or information-system protocols. This interoperability problem involving Technical Information within the DoD is, however, similar to same basic problem, albeit on a much greater scale, which has arisen as a result of the information explosion on a world-wide basis over the last few years.

The global need for interoperability at the end-user level has largely been satisfied by the World-Wide-Web (WWW) and Internet technology using a common Web browser. Such an approach is completely adaptable for deployment on an DoD intranet to resolve the similar DoD problems of establishing the needed interoperability.

Need for a New IETM Architecture

Recognizing both the need for greater TI interoperability in the Navy and the potential of WWW technology for providing a solution to the problem, the Naval Air Systems Command, and in particular the F/A-18 program, established an effort in 1996 to develop guidelines for the development and acquisition of IETMs in accordance with WWW approaches. This capability was to be established in such a way that any authorized end user could access all relevant information regardless of source, nature of the IETM-authoring system, or structure of the IETM. The Naval Surface Warfare Center, Carderock Division (NSWCCD), was assigned the technical responsibility for this task.

Through the Tri-Service IETM Technology Working Group (IETMTWG), chaired by NSWCCD, this project was briefed to the other Services, to the Office of the Secretary of Defense, and to the Joint Logistics Commanders Group for Communications and Electronics (JCG-CE). The Joint Logistics Commanders (JLC) and the Office of the Deputy Undersecretary of Defense (Logistics) (DUSD(L)) recognized both the problem of

assuring wide IETM interoperability and the applicability of the proposed solution on a Service-wide basis, and assigned to the IETMTWG the mission of broadening the approach to provide a new IETM architecture to attack the problem on a DoD-wide basis. This effort has been assigned to the IETMTWG, with technical input provided by the Army, Navy, Air Force, and Marine Corps, leading toward development of a suitable Joint IETM Architecture (JIA) and a suitable Pilot-Demonstration program involving candidate weapon systems from all of the Services.

The IETMTWG has, at this time, been chartered to provide a new DoD Information Architecture for IETM interoperability, specifically to:

- Develop a uniform approach for electronically communicating and accessing technical data throughout the DoD.
- Maximize the use of commercial off-the-shelf technology in the process.
- Develop a common user/information interface for field delivery systems.

Testing Architecture in a DoD Framework

Under the sponsorship of Assistant Deputy Undersecretary of Defense (Logistics Reinvention and Modernization), the Tri-Service IETM Technology Working Group will be demonstrating the applicability to the Joint IETM Architecture (a modification and extension of the Navy IETM Architecture [NIA] described herein) to a variety of representative DoD programs in FY99. Navy Department programs participating will include the F/A-18 Aircraft, the New Attack Submarine (NSSN), the E-6B aircraft, the LM-2500 Gas Turbine System, the Naval Sea Systems Command (NAVSEA) and Submarine Ship System Manuals (SSMs), as well as the Advanced Amphibious Assault Vehicle (AAAV) program

TRI-SERVICE IETM TECHNOLOGY WORKING GROUP

Reports to ADUSD(LR&M), formerly the OSD CALS Office

Initial Charter- 24 Aug 1989; Revised- 20 Jun 1997

Purpose: To foster the exchange of ideas and the agreement on a common approach regarding the acquisition of IETMs.

Membership:

Army- Logistics Support Activity (LOGSA), Huntsville AL

Navy- NSWC Carderock MD (Chair)

Air Force- Air Force Product Data Systems Modernization (PDSM), Wright-Patterson Air Force Base (WPAFB), OH

Marine Corps- Marine Corps Systems Command (MCSC), Quantico VA

Primary Current Task: DoD IETM Interoperability

of the Marine Corps. Army programs participating in the test include the AN/PPS-5, the Enhanced Position Location Reporting System (EPLRS) Net Control Station, and Apache Longbow. Planned Air Force programs include the General Methods and Procedures Technical Orders, F-22, and Joint Surveillance Target Attack Radar System (JSTARS). The evaluation program will address all levels of IETM functionality and cover the IETM spectrum from legacy systems to newly developed IETMs. The tests will cover the following products and/or standard formats: Adobe Portable Document Format (PDF), Air-Force Indexed Portable Document Format (IPDF), Boeing Quilt, General Dynamics TechSight, Navy Class-2 Standard Generalized Markup Language (SGML), Raytheon Advanced Integrated Maintenance Support System (AIMSS), Litton MediaLynk, Advanced Technical Information Support (ATIS) System,

Lockheed Martin F-22 Integrated Maintenance Information System (IMIS), Air Force/Grumman JSTARS IMIS (JIMIS), Navy Advanced Technical Information Support System (ATIS), and Internet Standard Hypertext Markup Language (HTML). These tests are planned to provide a comprehensive assessment of the proposed Web-based IETM Architecture.

The details below describe the completed Navy IETM Architecture (NIA) effort. The final NIA report has been widely distributed and is available on the NSWCCD Web Site, <http://navycals.dt.navy.mil>, under the IETM subtopic. The Joint IETM Architecture (JIA) will be similar in construct and philosophy; however, the results were not available at the time this paper was prepared and will not be formalized until the second quarter of CY 1999.

The Navy IETM Architecture (NIA) Development Effort

The objective of the NIA Study effort has been to create a high level IETM Architecture to guide and standardize IETM acquisition, management, and display that:

- [1] will enable, for the end user, maximum interoperability of Technical Information to meet the needs of the Naval Aviation community in supporting the Naval Logistics Information Strategy Plan;
- [2] will also serve as the basis for a DoD-wide adoption of the proposed approach, to be based on pilot-test programs that will assess the applicability of the Architecture to supporting IETMs for candidate weapon systems of the Military Services.

Goal for the Architecture

The primary goal for the Navy IETM Architecture is to set the foundation for the acquisition and deployment of sharable and interoperable technical data is distributed to the work location of an end-user, who will be able to view and utilize that data through a common user interface, no matter what the authoring source or data format. In so doing the Naval Aviation Community will be able to establish a

unified approach to the acquisition, management, and use of existing ETMs (Electronic Technical Manuals) and newly procured IETMs. To meet this goal, the overall approach will be based on the use of existing COTS and Non-Developmental Item (NDI) Internet and World-Wide-Web technology. An overall end goal is to achieve end-user-level interoperability of the IETMs delivered to and used by the Navy. In this context, an IETM is defined as having end-user interoperability when it can enable a user with a common, commercially available display device, such as a portable personal computer:

- [1] to view and interact with an IETM from any source and of any internal format; and
- [2] to view, by means of an electronic-link reference in the displayed IETM, information in any other IETM to which the link refers.

Technical Approach

The overall concept of this effort is to utilize the group of emerging technologies that the commercial marketplace is rapidly adopting as the standard for electronic documents based on the technology of the Internet and the World Wide Web. For security and operational reasons, the Navy will not, of course, utilize the actual Internet or the World Wide Web itself, but can employ essentially the same technology and COTS products in a private and dedicated DoD intranet environment. Such an approach is becoming the de facto standard for corporate information-distribution systems worldwide. Once this approach has been proved effective, a set of implementation standards will be developed within this comprehensive, DoD-wide, commercially supported (i.e., COTS) framework.

A major objective of the effort to develop the Architecture is to demonstrate end-user interoperability of proprietary and legacy Electronic Technical Manuals by encapsulating them into a common IETM View Package (VP) format which can be viewed by the end user employing a single commercially available user information interface, a process referred to in

this report as "object encapsulation". This demonstration requires the establishment of the following technical capabilities:

- [1] an authoring system to effectively create and manage IETMs (regardless of which authoring tool, etc., is used);
- [2] an infrastructure that permits a military component to distribute, manage, and present these IETMs; and
- [3] a system that permits an end user to perform his job effectively through access to required Technical Information, and that allows him to retrieve relevant data from other IETMs, including those of other Services, if necessary.

In order to achieve interoperability, the performance specification recommended for the NIA will be specific, but with the clear intent to not preclude innovative solutions, especially in light of the constantly expanding technology base. Achieving this balance has required making some decisions that may need to be reexamined over time. Whenever possible, the design adheres to open standards or de facto standards widely implemented by multiple vendors.

Overview of the Architecture

The NIA is firmly based on the proven and widely accepted Internet and World Wide Web technology, implemented as a private Web on a contained intranet. This intranet can be configured as a private DoD World-wide network (e.g., the Global Combat Support System [GCSS], as a ship or squadron-wide network (e.g., the NAVAIR Automated Maintenance Environment [AME] network envisioned for all Naval Aviation sites), or as a group of computers in close proximity hard-wired in an Ethernet configuration. It can also be configured in a single display device (portable or workstation personal computer) which operates both as a client browser and a personal single-user Web server.

The technology for implementing such an intranet is low-risk, easily implemented, and widely understood. The proposed architecture is

based entirely on COTS and NDI technology. The architecture is based on a dedicated Web or intranet that, at a minimum, has at least one Web-browser client, at least one Web server (more precisely, a Hypertext Transfer Protocol [HTTP] server and its included file-based store), and a network to connect them. The specific implementation of the network, which is typically a TCP/IP (Transmission Control Protocol / Internet Protocol)-based network when more than one device is involved, is not discussed in detail in this report and will typically vary from one implementation to another. As will be described more fully below, the intranet may include optional database servers and application servers as well as the HTTP server.

Use of Internet and World Wide Web Technology

The approach to developing a solution for this interoperability problem has been to adapt commercial and industry applications involving electronic documentation for which there is widespread vendor-product support. The Naval Aviation IETM Information Architecture Project is applying the products and standards being developed for the World Wide Web and the Internet in a dedicated private-intranet environment. The NIA has intentionally been designed to be extensible, flexible, and able to accommodate the predictable rapid growth in technology for all aspects of the Internet, the Web, and the emerging electronic documentation applications being developed to operate on the Web.

The Web is, by its nature a client/server architecture and there is one area on the client/server spectrum in which NIA compliant IETM Applications may differ in emphasis from a major server-centric trend that is emerging for many commercial "enterprise" applications. The NIA is intentionally biased towards a client-centric model employing encapsulated objects that are downloaded to a portable device for use. The server is treated as a utility electronic bookshelf with the IETM View Packages (i.e., the encapsulated objects) designed so they can easily be moved to another electronic bookshelf

at another physical site, reflecting the operational reality of the military unit itself. On the other hand, commercial Web sites tend to be permanently located corporate resource centers at which both the servers and the information providers are located. For these commercial activities, the mobile and less controlled entity is the user client. In this scenario, the preference is towards server-centric computing and the use of server-oriented Web-object components. The corporate personnel resources for maintaining both the Web server and the content are located at the Web site.

In the military, the server sites have more of the characteristics of a technical library and not a computer information center. The content related technical expertise lies with the content creator or the end user. This situation at this time favors total object encapsulation and client-centric computing as the primary emphasis of the NIA.

Progress in Web-oriented technology and the state of the availability of secure and affordable military global intranets may well change this situation in the future. Thus, the NIA proposed below is intentionally designed so to not preclude such server-centric solutions should such a change occur. In this light, it is important to emphasize that any implementing policy for the NIA must include some specific guidance on how to apply the Architecture, as well as, the requirement to conform to the architecture.

The use of custom servers is an important for which such guidance must be matured over time. Guidance documents for the NIA and any possible DoD wide expansion of the NIA must be continually updated over time. Such updates must be based on a continuing study of the emerging Military requirement compared to the current state of commercial technology and available COTS commercial products. The Naval Aviation Community or any other DoD component can not simply buy the latest and greatest commercially available technology without checking it against real Military requirements, which are not always the same as commercial requirements for which the products are often created

Following is a summary of initial recommendations for the Naval Aviation implementation of the NIA, as well as, the baseline requirement for the NIA.

Proposed Performance Specifications for the Architecture

In addition to assuming the widely known and accepted Internet/Web standards utilized in building any intranet based on the International W3 Consortium Standards, the IETM Improved Interoperability Architecture is being specified in the form of performance and interface specifications in the following areas:

- Object-Encapsulation Specification needed for definition of the delivery, transport, and structure of the IETM View Packages.
- Intranet Server and Database Interface Specification.
- Browser Specification.
- Electronic Addressing Specification.

The Object-Encapsulation, Intranet Server and Database Interface, Browser, and Electronic Addressing performance specifications are required to effect interoperability of disparate IETMs in the field. Achievement of interoperability implies the ability to view any IETM with any browser that conforms to the IETM Browser Specification. It thus requires that all cross references by one IETM to another IETM be encoded in a manner such that the IETM browser will be able to access the referenced IETM by a simple selection button "push" (e.g., mouse click).

In addition to these end-user interoperability specifications, the eventual complete Architecture recommended for Naval Aviation will include a Source-Data Sharing Specification in order to achieve interoperability of source data; that is, the ability for one authoring environment to automatically import source data from another authoring environment. The details in this Source-Data-Sharing Specification will be established by an additional phase of the study, which is still ongoing at the time of this writing. Below is a short summary of the five

specifications with a more detailed discussion of the first four presented later in this report.

OBJECT-ENCAPSULATION SPECIFICATION

A core philosophy underlying this architecture is that developers of IETMs can package and deliver, as a single data package composed of encapsulated objects called a View Package, all capability and content for an IETM that is needed to use the IETM on an unmodified standard Naval Aviation Intranet. This View Package may in fact contain both content data and software components and can be treated as an encapsulated data set for purposes of contract delivery to an electronic archive or subsequent store-and-forward management site. It will eventually be delivered by the Naval Aviation Infrastructure to the Fleet user activities as though it were a simple data package. Similarly, it will be treated by the Infrastructure as file-oriented data for the User Intranet Web Server, i.e., simply as a generic "bucket of sequenced bits" which makes sense to the server but is of no concern to the infrastructure as long as it is kept together. Essentially the View Package is a set of industry standard binary files, each of which is assigned a notional Universal Resource Locator (URL) which contains sufficient information for installation as data in the Intranet Server file system.

Until the point of receipt by the intranet server, the View Package is processed as a single object. There are a variety of mature approaches for bundling a set of files with headers into a single data set (e.g., INTERNET MIME [Multipurpose Internet Mail Extensions] Standards) and the Architecture may use any of them, requiring only that the View Package can be installed as a set of files on the intranet server. With this approach, no overt man-in-the-loop software installation processes are required other than the automatic capability built into the World-Wide-Web-capable browsers and servers.

SERVER AND DATA-BASE INTERFACE SPECIFICATION

The simplest way for the NIA to achieve IETM interoperability for the Naval Aviation Community is to utilize only primary generic

servers with widely available server extensions such as the Microsoft Front Page and Active Server Page extensions. Such an approach will require no additional software to be overtly installed on either the servers or the browser device. However, it is recognized that some legacy systems, and possibly some highly innovative new IETM applications, may require some sort of custom server extensions and database interface components. Final recommendations on the use and encapsulation of server extensions will require additional technical investigations as the technology and marketplace needs to mature before a full tradeoff and the development of specific recommendations can be accomplished.

BROWSER SPECIFICATION

The Browser Specification will specify the versions of the two dominant commercial browser products and a set of standard extensions (i.e., controls and/or plug-ins) to these browsers, which include common DoD data viewers such as PDF, an SGML viewer, CGM (Computer Graphics Metafile) Version 4 Graphics, and CALS raster images. The utility, functionality, maturity, and compatibility with the Navy's "IT-21" policy of the DCOM (Distributed Component Object Model) family of object broker standards is such that it will be recommended for the Naval Aviation implementation of the NIA. While Internet Explorer fully supports DCOM, there is a need for an extension of the Netscape browser to process Active-X Controls, the needed IETM related aspect of DCOM. The eventual goal is to have all valid DoD IETMs be compatible with both the Internet Explorer and Netscape products, possibly requiring some installed extensions.

ELECTRONIC ADDRESSING SPECIFICATION

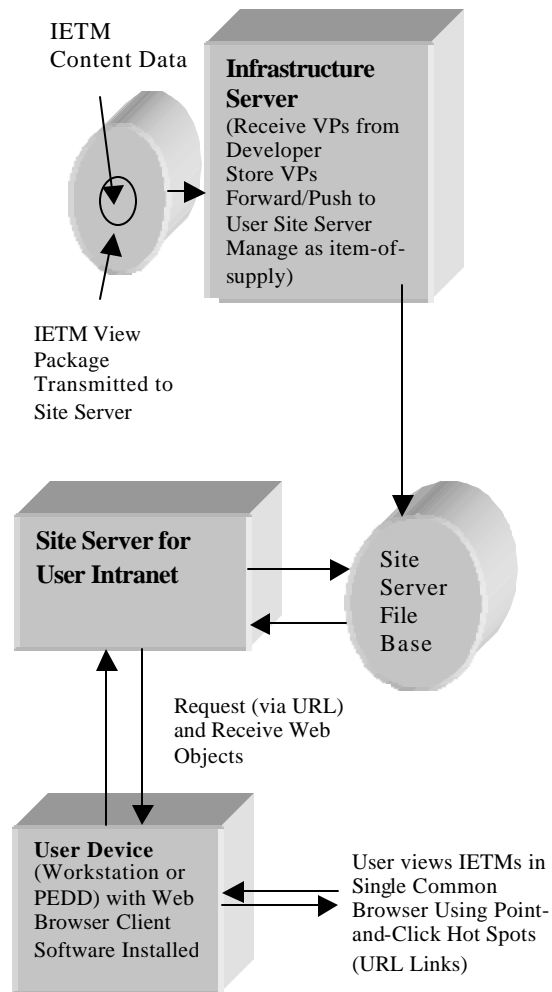
The Electronic Addressing Specification will be based on the existing Universal Resource Locator (URL) standard for the World Wide Web because it is widely implemented in virtually all Web-enabled vendor products. Any occurrence of a legitimate URL string of characters is automatically made "hot" in the

vendor application and a mouse click or two on that hot spot will launch a Web browser search which in turn will locate the file referenced by the URL and display it on the screen. In addition to requiring a standard syntax, the Electronic Addressing Specification will also require that all of the Services maintain and publish a permanent registry of all valid references to the IETMs issued by that Service. Once published, a valid URL must not be changed. This type of URL is called a persistent URL. The NIA assures that the URLs need not change over time by requiring URLs that do not reference an actual physical server on any particular network. (Note: the NIA calls these Persistent URLs - P/URLs. The JIA will call these virtual URLs - vURLs.) The specification will address the requirement in an intranet environment to remap these virtual URLs (which reference a hypothetical server on the World-Wide Web) into the actual server and file-system locations on the intranet under use.

NIA Operational Flow Diagram

The following (Figure 1) illustrates the flow of an NIA implementation from the original IETM developer, through the management infrastructure repository, to the user-site intranet server, to the Web browser viewing area and eventually to the user who selects the next object to view via a point-and-click Web-browser interface. The presentation components referred to can be client software components or server software components. They can also be implied (i.e., omitted) in the case when they are preinstalled in the standard browser. These Architectural Types are variants of this overall flow diagram and are described below.

Figure 1 – Flow of IETMs through the NIA



The User Perspective

The end user accesses and views the IETMs in the following manner. The typical device that a technician will access is a workstation personal computer or a PEDD (Portable Electronic Display Device). This device will be configured either as a network client attached to the squadron intranet or it will be configured to operate in stand-alone mode. In either case the man-machine interface is identical and the user cannot determine from the look and feel of a display in which mode the device is operating. To access an IETM, the user will employ an URL reference using one of the many access-screen or menu-select options available (e.g., favorites list, explicit entry, a pre-assembled list

of active IETMs on a squadron Home Page, a hot-spotted index graphic, a Web-page job-assignment form listing the needed technical references). All of these are common practices borrowed from the World Wide Web community. From the user's perspective the referenced IETM simply appears in the browser window.

Depending on the browser security level set, the user may at times need to overtly accept components that require installation, but no other explicit installation action is needed as the browser installs the components automatically. This is a key user-friendly feature of the NIA. Thus, there is no need for a system administrator to install user software; that is a part of the simplicity of this approach. Web access is a proven "point and click" user interface. If one IETM contains a reference to another IETM, the user can click on the reference and that IETM will appear in the browser window (assuming, of course, it is installed on the user's intranet). This second IETM can in turn reference a third IETM. To return to the original IETM, the user simply uses the "back" arrow on the browser interface, effectively reversing the references. Modern Web browsers can handle many levels of such nested referencing with no performance degradation, a very powerful feature. From the user perspective the NIA is thus intended to make the use of the disparate IETMs as easy and "seamless" as possible with modern technology.

The IETM Developer Perspective

The principal emphasis from the IETM-developer perspective is that all software components and data needed to make an IETM accessible on the NIA display device are bundled into a single data product (i.e., the encapsulated object), which is easily installed as a set of data files onto an intranet-server file system. This set of encapsulated objects is called a View Package. All data and component delivery to the end user is accomplished through the Web-based client-server interaction. An additional feature is that this View Package can be passed, unmodified, from server to server as part of the NIA electronic-distribution system. While the technology needed to accomplish this

transfer is complex, it is off-the-shelf and neither expensive nor difficult to obtain. This is due to the exploding popularity of the Internet and the World Wide Web for commercial applications and the rush by suppliers to get competitive products to market.

A foundational principal of the NIA is that the products developed for the Internet can be used unmodified to develop IETM products for an NIA-compliant Intranet. This process is in sharp contrast to a conventional IETM application where the IETM product is delivered as two separate items, the IETM content data and the IETM presentation-system application-software program. The latter requires an explicit installation process onto every applicable end-user device even if it is co-located on the same CD-ROM (Compact Disc/Read-Only Memory) as the data. There are many options for the required object encapsulation, however, those specific methodologies are not specified in the NIA. Only the Web-based interface to the object is specified.

The Infrastructure Perspective

The key NIA concept for the Infrastructure designer and user is that the IETM View Packages are composed of self-contained digital objects which appear to the infrastructure as large standard binary formatted digital files. These objects can be received from a developer, stored, forwarded, and delivered from one server to another without the end user's ever needing to know the internal structure of the View Package itself. The infrastructure site can function more as a supply center than as an information-systems center. The specific design of and development of recommendations for a Naval Aviation Infrastructure was not in the scope of this reported effort. This will undoubtedly be a complex, difficult, but important task that will be complicated by the impact it will have on many existing business practices. However, this key NIA element, that the objects can be processed as an item of supply, with no requirement to manage the internal content or structure of the object, should make this task much more manageable.

Integrated Product Support Database (IPSDB) Using the Navy IETM Architecture

This report closes with the following recommendation for increasing the applicability of this Web-based architectural model to applications other than IETMs. The above-described Architecture can apply to any of the components of an Integrated Product Support Database (IPSDB), including training products used to support a weapon system in the field. In developing integrated support for a product, which includes IETMs as well as training modules, it should be the DoD position to discourage the development of proprietary monolithic IPSDBs for individual weapon systems. Instead, it is recommended that a strategy be developed for using the proposed unified IETM architecture to provide IPSDB functionality incorporating field technical training, diagnostics, and logistic support products. The family of general-purpose commercial products being developed for private intranet Web servers utilizing Internet World Wide Web technology can provide all the functionality needed and should be adopted instead of applying traditional customized application software approaches usually employed to develop custom DoD product-support systems.

Bibliography

Fuller, Joseph J. 1994. IETMs- From Research to Reality. *CALS Expo '94 International Proceedings*.

Fuller, Joseph J., et al. 1988. Test and Evaluation of the Navy Technical Information Presentation System (NTIPS). AN/SPA-25D Test Results. David Taylor Research Center. DTRC-88-035.

Fuller, Joseph J. and Eric L. Jorgensen. 1997. Integrated Data Environment and Interactive Electronic Technical Manuals (IETMs). *DoD Logistics Reform Focus Day Proceedings*. Department of Defense.

Fuller, Joseph J., Theodore J. Post, and Anne S. Mavor. 1988. Test and Evaluation of the Navy Technical Information Presentation System

(NTIPS), F-14A Field Test Results. David Taylor Research Center. DTRC-88-036..

Fuller, Joseph J. and Samuel C. Rainey. 1992. The Interactive Electronic Technical Manual. *CALS Journal*. Volume 1, Number 4.

Fuller, Joseph J., Samuel C. Rainey, and Theodore J. Post. 1996. Maintenance and Logistic System-Support Benefits Resulting From Introduction of IETM-Based Technology. Carderock Division, Naval Surface Warfare Center. NSWCCD/TSS-97/02.

Fuller, Joseph J. and Tri-Service IETM Technology Working Group. 1998. Plan for DoD-Wide Demonstrations of a DoD Improved Interactive Electronic Technical Manual (IETM) Architecture. Carderock Division, Naval Surface Warfare Center. CDNSWC-TSSD-98-006.

Jorgensen, Eric L. 1998. Proposed Web-Based Architecture for the Interoperability of Naval Aviation IETMs. Carderock Division, Naval Surface Warfare Center. CDNSWC-TSSD-98-005.

Jorgensen, Eric L. and Joseph J. Fuller. New Approaches for Navy Technical Training and Job Performance Aiding Using Expanded IETM Technology. 1996. Carderock Division, Naval Surface Warfare Center. NSWCCD/TSS-97-01.

Jorgensen, Eric L. and Joseph J. Fuller. 1993. Standards for Interactive Electronic Technical Manuals. *Proceedings of the 1993 Naval Sea Systems Command International Logistics Symposium*. American Society of Naval Engineers.

Jorgensen, Eric L. and Joseph J. Fuller. 1993. The Interactive Electronic Technical Manual. *ASNE Logistics Symposium Proceedings*. American Society of Naval Engineers and Society of Logistics Engineers.

Kramer, Mark T., Theodore J. Post, and Samuel C. Rainey. 1993. Results of a Joint Navy/Air Force Operational Test to Evaluate USAF Integrated Maintenance Information System (IMIS) Interactive Electronic Technical Manual (IETM) Technology Applied to the F/A-18 Aircraft. Naval Surface Warfare Center, Carderock Division. CARDEROCKDIV-93/007.

Military Performance Requirements Document MIL-PRF-87268A. 1995. Manuals, Interactive Electronic Technical: General Content, Style, Format, and User Interaction Requirements For.

Military Performance Requirements Document MIL-PRF-87269A. 1995. Data Base, Revisable: Interactive Electronic Technical Manuals, For The Support Of.

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